Estimating associations between source-apportioned particulate matter and emergency department visits in multicity studies

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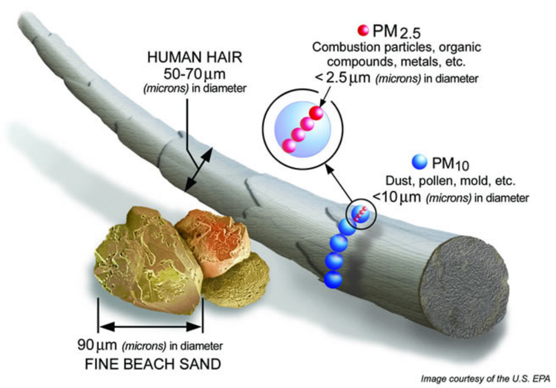
Background

- Total mass particulate matter (PM) air pollution has been associated with mortality and morbidity
- Some evidence that PM less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$) is more toxic than other size distributions



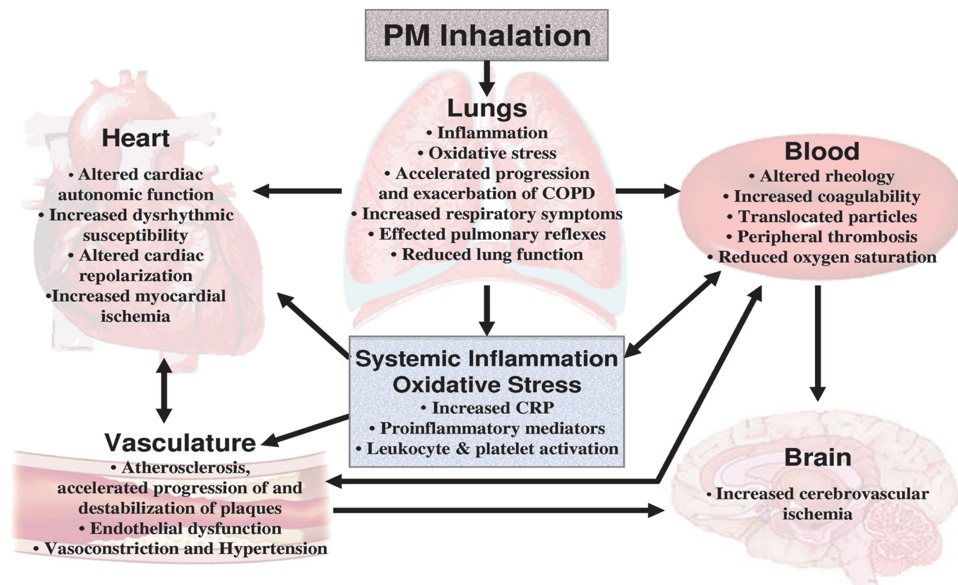
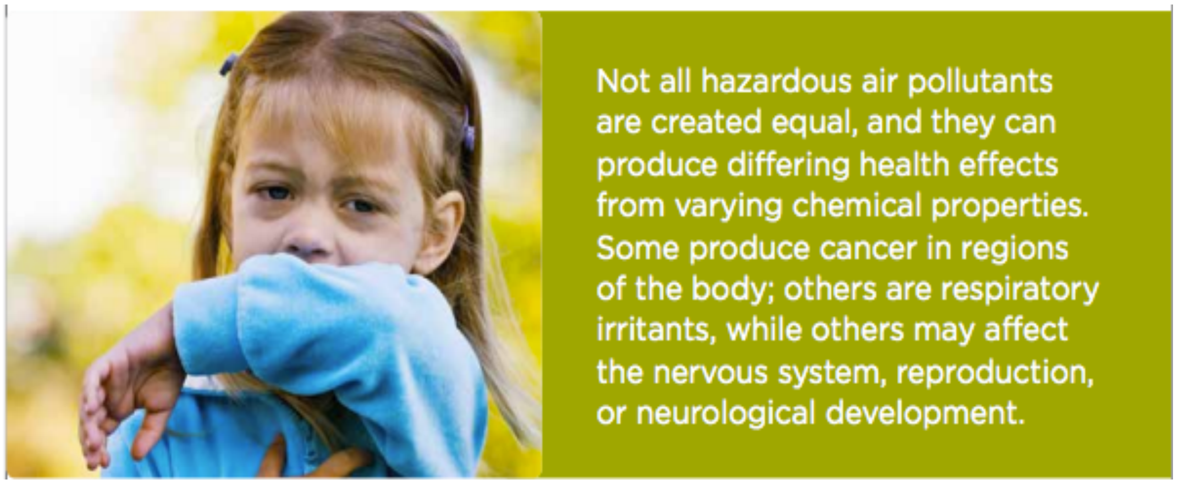


Figure 4. Potential general pathophysiological pathways linking PM exposure with cardiopulmonary morbidity and mortality.

Pope and Dockery (2006) ***J. Air & Waste Manage. Assoc.***

Background

- $PM_{2.5}$ is a temporally and spatially varying mixture of chemical constituents
- $PM_{2.5}$ is generated by both anthropogenic and natural sources
- Sources of $PM_{2.5}$ likely vary in their associations with adverse health outcomes

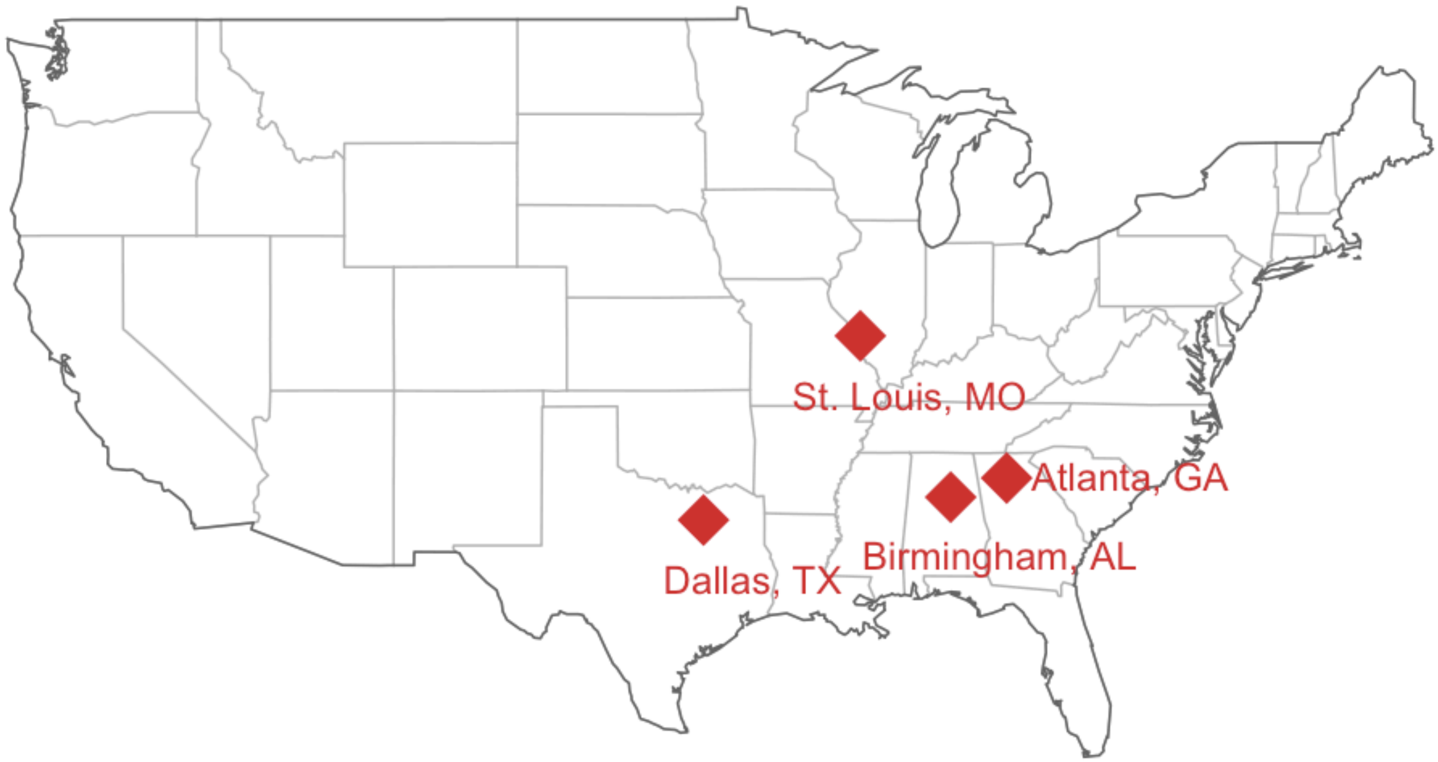


Pittsburgh Regional Threats Analysis Report (2013)

Aim

To compare across 4 US cities:

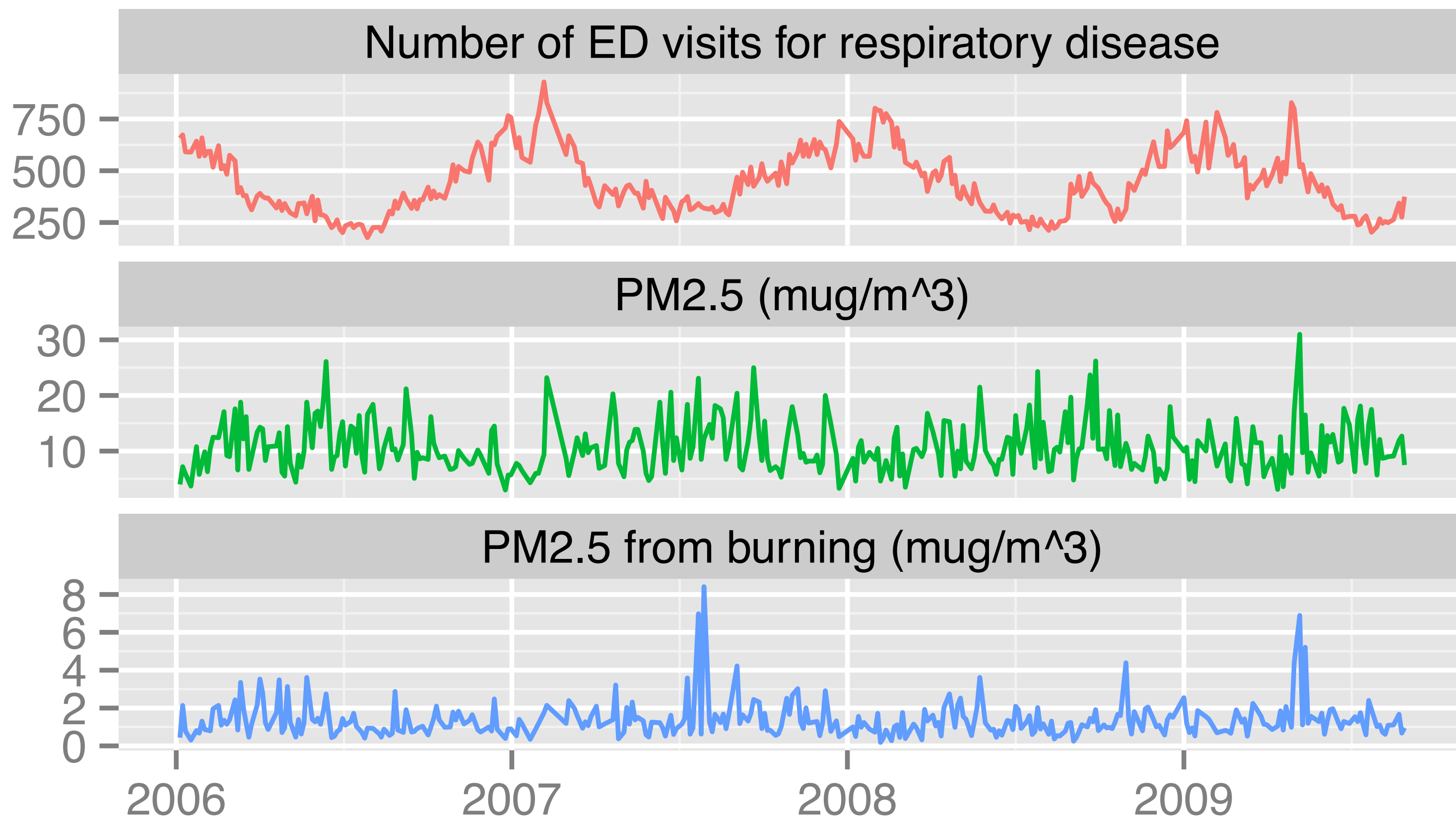
- Sources of $PM_{2.5}$
- Associations between sources of $PM_{2.5}$ and emergency department (ED) visits for respiratory diseases



Data

For each city:

- Daily ED visits for respiratory diseases
- Total $PM_{2.5}$ mass and $PM_{2.5}$ chemical constituents from a central monitoring site
- Source-apportioned $PM_{2.5}$ estimated from $PM_{2.5}$ chemical constituents

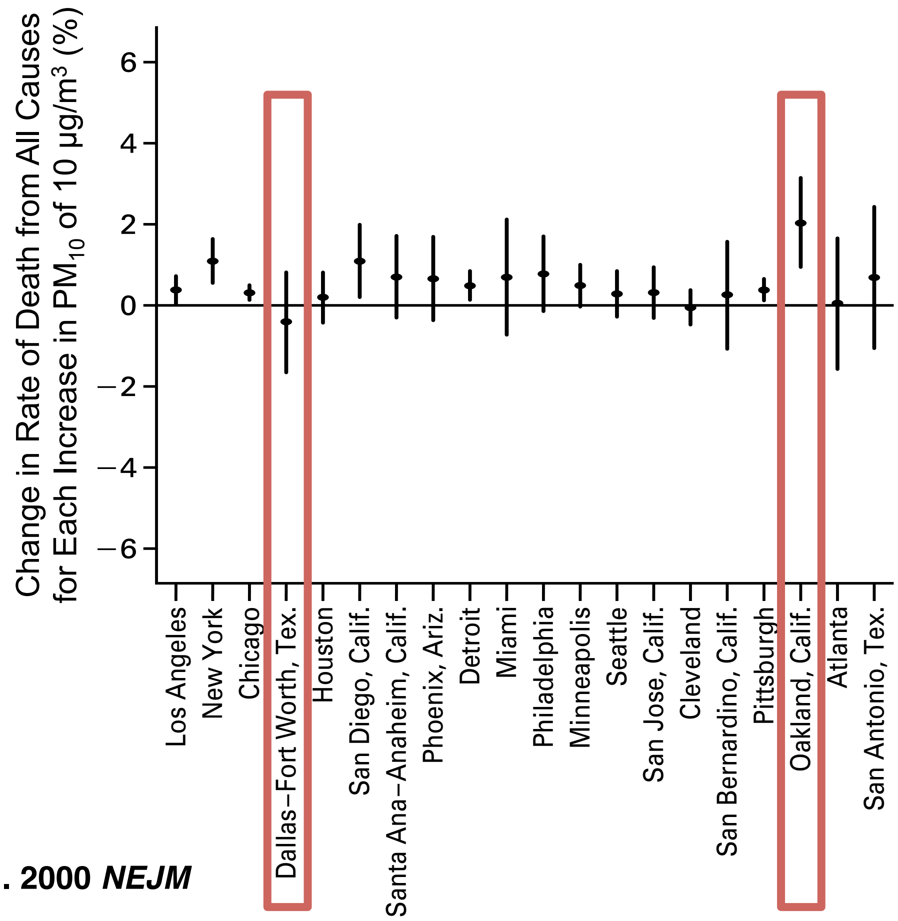


Challenges for multicity epidemiologic studies of PM

Between-city heterogeneity in estimated health effects may be driven by

- Differences in population or exposure characteristics
- Differences in particle chemical composition

What population characteristics drive between-city differences?



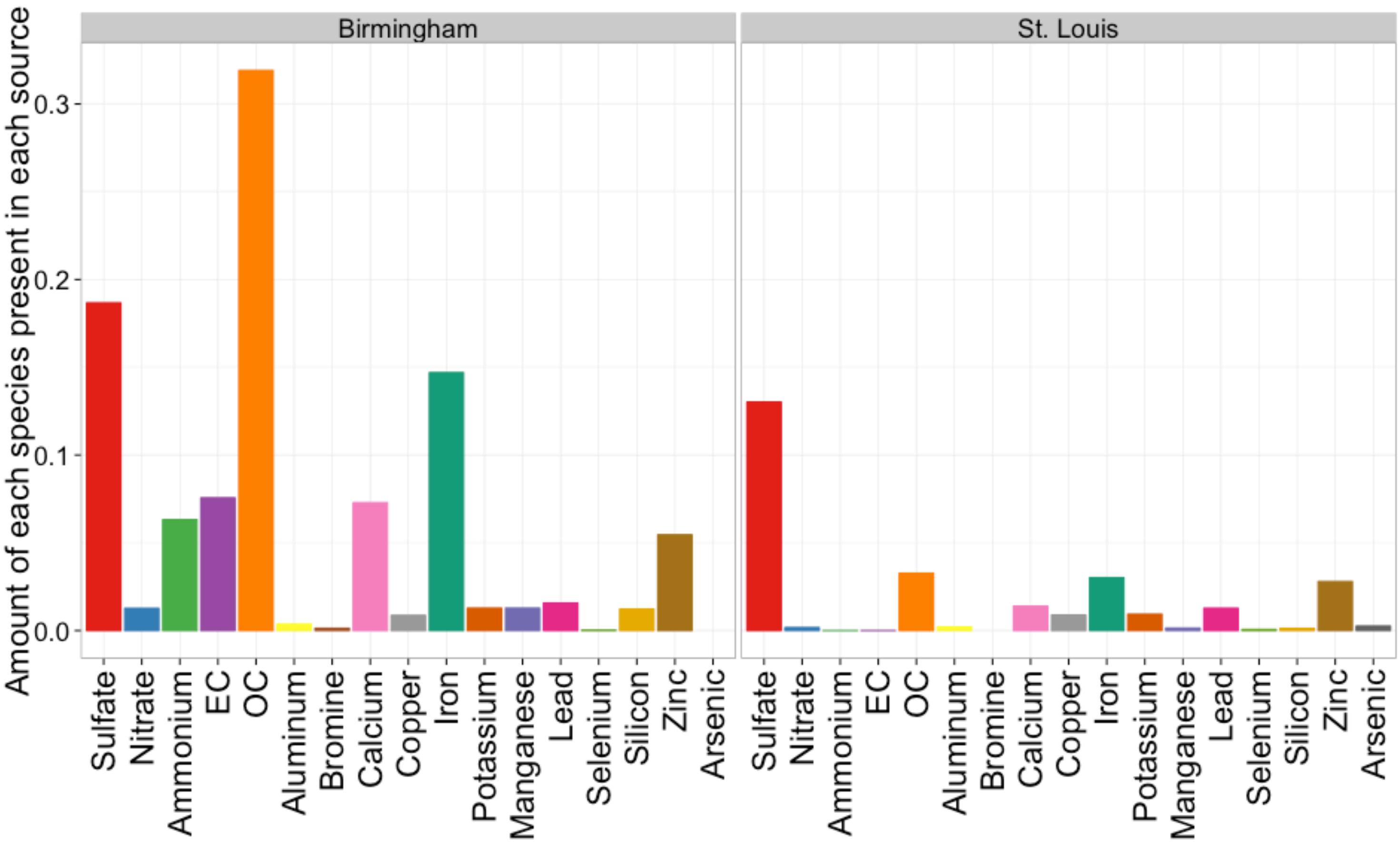
Reproduced from Samet et al. 2000 *NEJM*

Challenges for multicity studies of sources of $PM_{2.5}$ and health

- Sources of $PM_{2.5}$ estimated separately for each city
- Sources of $PM_{2.5}$ vary in chemical composition between cities

Between-city heterogeneity could also be driven by differences in source composition

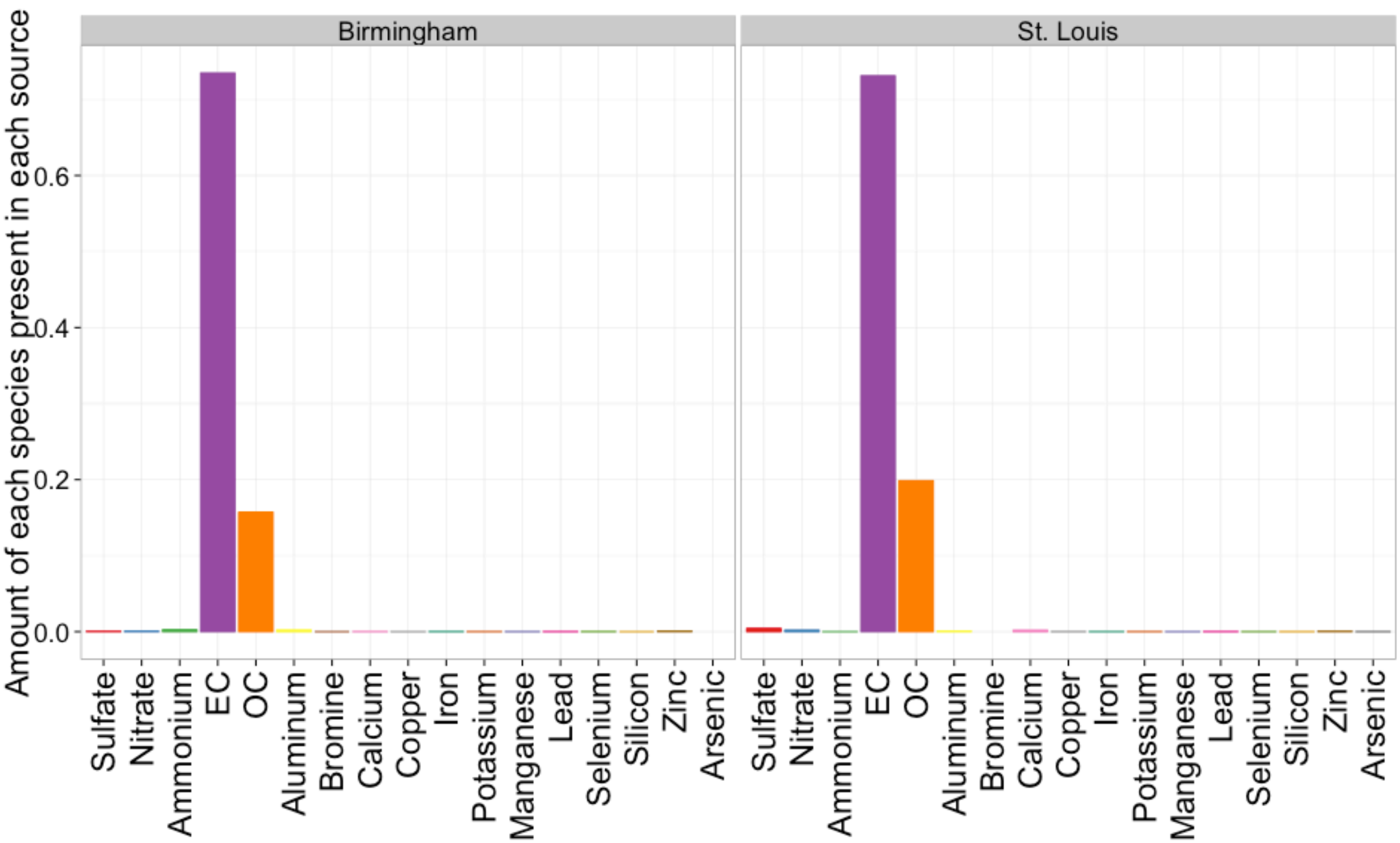
$PM_{2.5}$ from metals source



Challenges for multicity studies of sources of $PM_{2.5}$ and health

- Some sources similar in chemical composition across cities
- By only comparing "similar" sources across cities, can eliminate one source of between-city heterogeneity

$PM_{2.5}$ from diesel vehicles



Data: Source-apportioned $PM_{2.5}$ for 4 US cities

Primary sources of $PM_{2.5}$ identified using central monitoring site data

Source	Atlanta	Birmingham	St. Louis	Dallas
Mobile				
Gas vehicles				
Diesel vehicles				
Biomass burning				
Coal combustion				
Metals				
Dust				

Source identified	
Source not identified	
Not reliably estimated	
Source obtained by average	

Data: $PM_{2.5}$ source profiles in summer

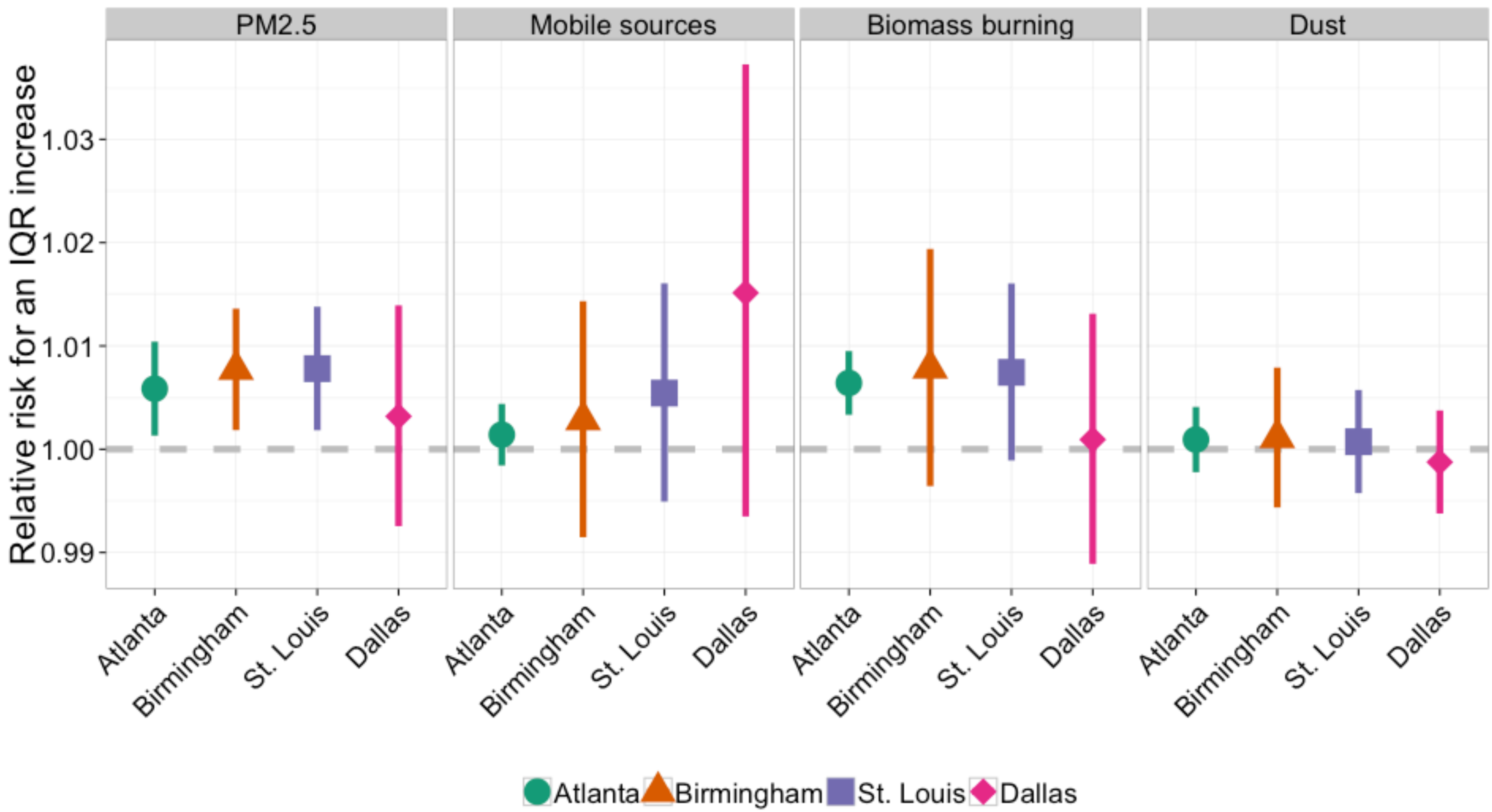
Results: Chemical compositions of sources across cities

- Correlation between source profiles across cities
- Mean squared differences in source profiles (x 100) across cities

Source	Number of cities	Correlation average (min, max)	Mean squared difference (x 100) average (min, max)	Pairwise comparisons
Gas vehicles	4	1.00 (1.00, 1.00)	0.01 (0.00, 0.03)	12
Diesel vehicles	4	1.00 (1.00, 1.00)	0.03 (0.01, 0.06)	12
Dust	4	1.00 (0.99, 1.00)	0.00 (0.00, 0.01)	12
Biomass burning	4	0.99 (0.97, 1.00)	0.05 (0.01, 0.11)	12
Coal combustion	**3**	**0.69 (0.48, 0.98)**	**0.23 (0.04, 0.39)**	**6**
Metals	**2**	**0.67 (0.59, 0.74)**	**0.61 (0.52, 0.71)**	**2**

Results: Estimated health effects across cities

Estimated associations between lag 2 $PM_{2.5}$ mass and source-apportioned $PM_{2.5}$ and ED visits for respiratory diseases



Conclusions and future work

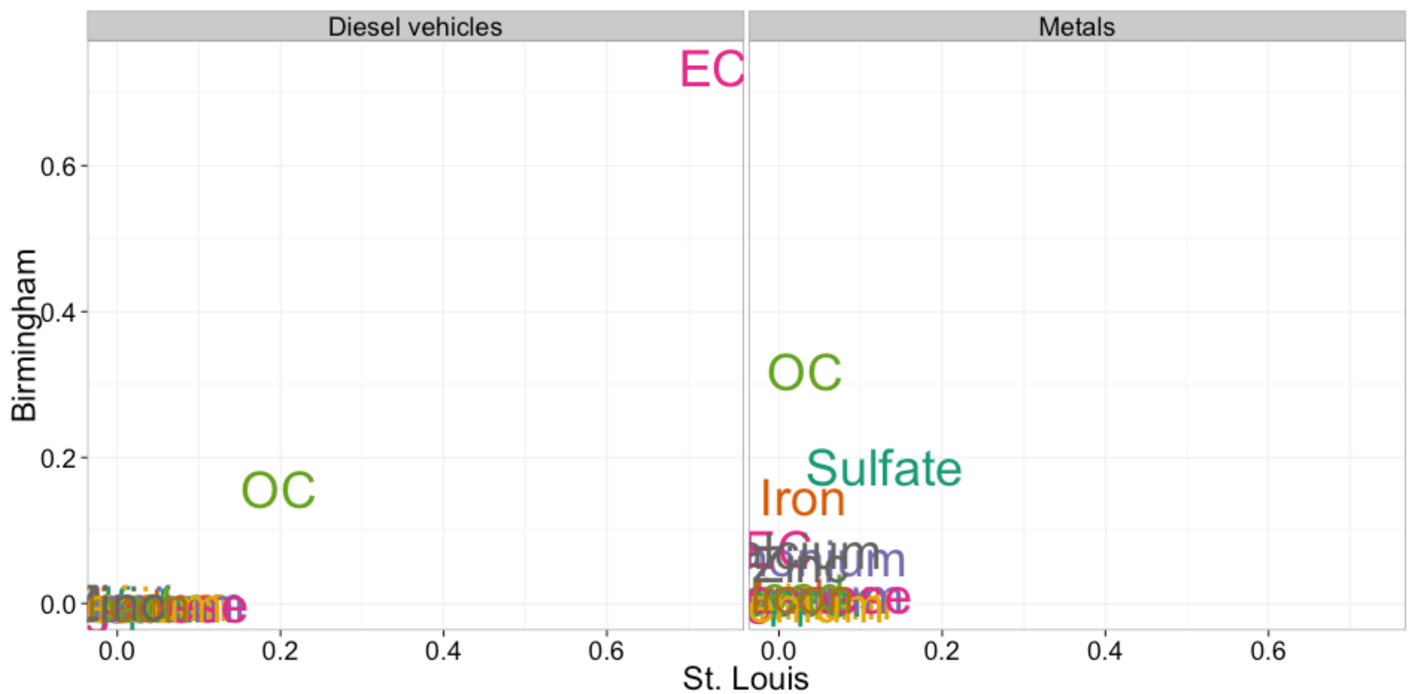
Conclusions

1. Chemical compositions of $PM_{2.5}$ from metals and coal combustion vary across cities
2. Found some evidence of associations between biomass burning $PM_{2.5}$ and ED visits for respiratory diseases

Future work

1. For comparing source profiles, how different is too different?
2. What is the best way to compare profiles?

Visually comparing profiles between St. Louis and Birmingham



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